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Description

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to an improvement in an optical fiber system for transmitting a laser beam.

Recently, power transmitting optical fibers have become widely used in industry, medicine and the like. The term "power" includes high laser power. Typical lasers include carbon dioxide lasers, YAG lasers, Ar lasers and the like. YAG lasers, Ar lasers and the like, can transmit through a quartz glass fiber. However, light from a carbon dioxide laser can not be transmitted through a quartz fiber because of its long wave length. Although it can be transmitted by means of a mirror, the structure of articulation is so complicated to make use difficult. However, crystalline fibers of silver halide, thallium halide, and alkali halide can transmit the light of the carbon dioxide laser.

Advantages in light power transmission by means of optical fibers are such that light can be conducted into even a narrow space and along a complicated path having many bent portions to irradiate any object. This is because an optical fiber has superior characteristics such as small diameter, flexibility and so on.

Although one end of the optical fiber is connected with a laser source, the other end is often exposed because it is necessary to emit a laser beam therefrom toward an object to be irradiated with the laser beam. However, the end from which the laser beam is emitted (hereinafter simply referred to as "a light-emitting end"), is often inserted into a narrow space, into a space having many bent portions, or into a space filled with a liquid or a solid, so that the light-emitting end is apt to be damaged. Foreign matter, such as dust, drops of water, blood, or the like, may adhere on the light-emitting end of an optical fiber used for power-transmitting a laser beam, depending on the environment in which the optical fiber is used.

If a laser beam is passed through an optical fiber with foreign matter adhered on its light-emitting end, the foreign matter is heated by the laser beam and sometimes burnt and stuck on the end surface of the optical fiber. If this happens, transmission deteriorates, and the temperature sharply rises as the laser beam energy is absorbed by the foreign matter, damaging the light-emitting end of the optical fiber.

A similar type of problem of preventing the light-emitting end of a laser probe from being damaged is described in WO85/05263. This document presented a solution to this problem by providing a forward end protecting cover at the fibre tip of the laser probe and also additionally providing a gas discharge means for cooling and expelling any foreign matter from the end of the laser probe. However, this prior art has only to be taken into consideration with respect to Article 54 (3) EPC.

In the industrial field of laser beam working machines as is, for example, described in US-A-4010345 then conventionally a gas delivery means for providing a flow of gas is employed in order to keep clean the workpiece which is being cut by the beam of laser radiation.

On the other hand, in other types of light transmitting apparatuses, conventionally, an opening/closing cover has been provided at the light-emitting end of an optical fibre to prevent such accidents. The cover is opened only when a laser beam is emitted and closed when no laser beam is being emitted. Thus, the light-emitting end of the optical fibre is protected by the cover when no laser beam is emitted. However, the laser beam per se has no power to prevent dust, blood, drops of water, or the like, from adhering onto the light-emitting end. When the light-emitting end of the optical fibre is put in an environment containing liquid, such as water drops, blood, or the like, the liquid may adhere to the light-emitting end when the protecting cover is opened during emission. This deteriorates the transmittivity at the end surface to extremely reduce the treating capability of the laser beam.

Further, the light-emitting end may be sometimes broken because the end surface is sharply heated. There are two kinds of opening/closing mechanisms, one being of the type provided at the forward end of an optical fiber and the other being of the type provided in the back of an optical fiber and controlled remotely.

An opening/closing mechanism at the forward end of an optical fiber is provided with a motor, a reduction gear, gearing, and so on, attached at that end to open and close the cover by the forward and backward rotation of the motor. In such a cover opening/closing mechanism, it is necessary to attach a motor, a reduction gear, a gearing, and so on, at a light-emitting end of an optical fiber, so that the end of the optical fiber becomes bulky, loses flexibility and becomes heavy. Moreover, it is necessary to incorporate electrical conductive lead wires in the optical fiber as a power feeder and a signal line for the motor, so that the structure of the optical fiber becomes complicated.

Thus, if a prime mover is attached at the light-emitting end, the light-emitting end becomes heavy and bulky. Therefore a mechanism has been proposed to remotely operate the cover. In this mechanism, a motor, a reducti n gear, and the like are provided not at the light-emitting end of an

optical fiber but in the vicinity of the light source. A cover opening/closing portion urged in one direction by a spring and pulled in the reverse direction by a wire is provided at the forward end of the optical fiber. The motor, or the like, and the cover opening/closing portion at the forward end of the optical fiber are connected with each other by a wire extending along the optical fiber.

Thus, the mechanical structure provided at the light-emitting end of the optical fiber is reduced in size as well as in weight and becomes easier to use. The wire, however, must be provided along the fiber, so that the structure of the optical fiber becomes complicated. Also the flexibility at the intermediate portion of the optical fiber is reduced.

It is therefore an object of the present invention to provide a high laser power transmission optical fiber arranged to prevent foreign matter from adhering to and burning on the light-emitting end of the optical fiber.

It is another object of the present invention to provide a power transmission optical fiber with a cover opening/closing mechanism which has few mechanical parts so as to make failures few.

It is a further object to provide a power transmission optical fiber with a cover opening/closing mechanism at the light-emitting end of the optical fiber and arranged so as not to make the light-emitting end of the optical fiber heavy and bulky and so as not to make the structure of the optical fiber complicated, so that the flexibility of the optical fiber is not lost and that the operation is improved because the light-emitting end of the optical fiber is small in size as well as light in weight.

In the optical fiber according to the present invention, an openable/closable protecting cover is provided at the light-emitting end of the optical fiber, whereby the cover provided at the light-emitting end is made of a shape memory alloy so as to open and close in response to laser beam power per se.

The cover is made of such a shape memory alloy so as to store such a shape that the cover closes at a low temperature and opens at a high temperature.

The shape memory alloy can be transformed by the power thereof into a previously stored shape if the temperature is changed. The laser beam per se is used to change the temperature.

Upon being driven, a laser beam is emitted from the light-emitting end of the optical fibre and impinges onto an inner surface of the cover made of the shape memory alloy. Because the laser beam has large power, the temperature at the cover is raised. Storing a shape to open at a high temperature, the cover is opened as the temperature is raised.

When the laser beam is no longer emitted from the light-emitting end of the optical fibre the temperature at the cover is lowered, and the cover is closed. The temperature at the cover is low r d fairly rapidly as heat is lost due to radiation, conduction, and convection. Thus, the cover can be closed in a relatively short time after the laser beam has been extinguished.

In a preferred embodiment, a blower is provided at the light source end of the optical fibre to feed a gas to the light-emitting end along the optical fibre to remove liquid from the vicinity of the light-emitting end to thereby protect the light-emitting end. In a further preferred embodiment, a gas pressure sensor is provided to monitor the pressure of the gas in the vicinity of the light-emitting end.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the drawings, the optical fiber according to the present invention will be described hereunder.

Fig. 1 is a diagram showing the whole arrangement of the optical fiber according to the preferred embodiment of the present invention.

Fig. 2 is an enlarged cross-section showing a portion in the vicinity of a light-emitting end.

Fig. 3 is a cross-section showing the structure of the light-emitting end of the optical fiber according to the present invention, in which the cover is in the closed state.

Fig. 4 is an enlarged front view of the light-emitting end.

Fig. 5 is a cross-section showing the structure of the light-emitting end of the optical fiber, in which the cover is in the open state.

Fig. 7 is a front view of the light-emitting and opening/closing cover constituted by eight divisional members.

Fig. 8 is a longitudinal cross-section showing the state in which the forward end portion of the optical fiber is inserted into a thin pipe and is emitting a laser beam.

DETAILED DESCRIPTION OF THE DRAWINGS

Optical conductor 1 is a member provided in the center of the optical fiber for conducting a laser beam. As described above, the optical conductor has a small diameter and sufficient flexibility to be bent as desired. In the case of a carbon dioxide laser, crystal fibers of silver halide, thallium halide, and alk li halide are used. In th case f a YAG and an Ar lasers quartz glass fibers are employed. The material is selected based on the wavelength of the laser. The whol of the optical conductor 1 is covered with a protecting inner layer 2 which is

made of flexible synthetic resin. An openable/closable forward end protecting cover 3 is provided at the light-emitting nd S of optical conductor 1.

The whole of the protecting inner layer 2 is surrounded by a protecting outer layer 4 such that a space is provided between the inner and outer layers so as not to lose flexibility. According to the present invention, gas pumped or sucked through the space and therefore the space is hereinafter referred to as ventilation path 8.

The other end of the optical fiber is connected with a laser source 5 which may be a carbon dioxide laser, a YAG laser, an Ar laser, or the like. The end of the optical fiber near the light source is referred to as a light source end T. According to the present invention, a blower 6 or gas feeder/suction means and a gas pressure sensor 7 are provided in the vicinity of the light source end T of the optical fiber. Pressure in the optical fiber is monitored by the sensor 7. The gas feeder/suction means 6 supplies gas to the end portion of the optical fiber, or sucks the gas if gas pressure exceeds predetermined value.

Various structures have been proposed for opening/closing the forward end protecting cover. In one of the proposed mechanisms of the type in which the cap is mechanically opened/closed, a motor as a driving source is provided in the vicinity of the light-emitting end of the optical fiber. Lead wires are passed through the protecting outer layer. There is another mechanism in which a motor is provided at the light source end of the optical fiber and the forward end protecting cover is opened/closed by a wire. The wire is passed through the protecting outer layer of the optical fiber. There is a third mechanism in which the forward end protecting cover is opened/closed by hydraulic or pneumatic pressure. A transmission line for the pressure liquid or gas is made by inserting a tube within the protecting outer layer.

In the present invention, however, a shape memory alloy is used as a mechanical forward end protecting cover.

The gas feeder/suction means 6 and the protecting outer layer 4 are connected with each other through a connecting tube 16. The gas pressure sensor 7 and the connecting tube 16 are connected with each other through a connecting tube 17. As shown in Figure 2, the forward end protecting cover 3 is constituted by a boss portion 14 and an opening/closing cap portion 15. Ventilation holes 9 are provided so as to axially pass through the boss portion 14. The ventilation holes 9 open into a space surrounded by the forward end protecting cover 3 to communicate with the ventilation path 8 surrounded by the protecting outer layer 4.

Shape memory alloy is an alloy having shape-restoring forc on the basis of thermoelastic martensitic transformation and reverse transformation. Here, a closed state at a low temperature and an opened state at a high temperature are stored. Alloys of Ni-Ti, Cu-Sn, Cu-Zn, Cu-Al, and the like, can be used as a shape memory alloy. Each of those alloys has a stable shape which is determined depending on a temperature and can store a shape at a temperature equal to or lower than a predetermined value as well as another shape at a temperature equal to or higher than a predetermined value, so that the alloy can be changed in its shape by being heated/cooled.

For example, Ni-Ti alloy consists of Ni of 50-60% by weight and Ti of 40-50% by weight. The alloy has restoring force on the basis of thermoelastic martensitic transformation and reverse transformation to thereby change the shape.

The temperature at which the shape transformation occurs, that is, the transformation temperature, can be adjusted by selecting the compounding ratio of the alloy. Although the Ni-Ti alloy is representative, an alloy in which Ni or Ti is partially substituted by Al, Cu, V, Zr, Cr, Mo, Fe, Co, or the like, may be used.

The light-emitting end opening/closing cover 3 is made of metal and preferably has such a shape that two divisional members are combined with each other as shown in Fig. 3 and Fig. 4. The cover 3 is provided at its root with a cylindrical attaching portion 18 for fixing the cover 3 between the inner and outer layers of the optical fiber. The inner diameter of the attaching cylindrical portion 18 is made to agree with the outer diameter of the protecting inner layer 2. The cover 3 has an intermediate cylindrical portion 19 in front of the attaching cylindrical portion 13 and an opening/closing cap portion 20 covering the front end of the optical fiber 1 in front of the intermediate cylindrical portion 19. The cap 3 is constituted by the two divisional members. A dividing line 21 appears on the front surface of the opening/closing cap portion 20.

The light-emitting end opening/closing cover 3 has an inner space 22 encircled by the intermediate cylindrical portion 19 and the opening/closing portion 20 thereof. In the drawing, the optical conductor 1 is projected a little into the inner space 22. However, the degree of projection of the conductor 1 is selective and there is no obstacle even if the respective front end surfaces of the protecting inner layer 2 and the optical conductor 1 are made even.

When a laser beam is emitted from the light-emitting end, the laser beam 5 impinges onto the back surface of the light-emitting end opening/closing cover 3. The laser beam has con-

siderable power. A part of the laser beam is reflected and the remainder absorbed by the back surface of the cover 3. The absorbed light sharply raises the temperature of the light-emitting end opening/closing cover. Therefore, the opening/closing cap portion 20 is opened at the dividing line 21. Fig. 5 shows the opened state.

If the rate of the reflected light is large, the respective end portions of the optical conductor 1 and the protecting inner layer 2 may be damaged by the heat. Accordingly, it is preferable to reduce the reflection factor on the back surface of the opening/closing cap portion 20. For this reason, the back surface of the opening/closing portion 20 is preferably colored black or made rough.

In this embodiment, cover 3 is constituted by two divisional members. This is possible when the cover is very thin. Even in such a shape memory alloy, it is impossible to easily change the thickness thereof, so that a distance between any two points is substantially maintained before and after transformation owing to heat. A shape memory alloy is not capable of expansion and contraction.

Thus it is advantageous to divide the opening/closing cap portion 20 into three to eight members. If the cap portion 20 is divided into eight members, eight dividing lines are formed and the central angle of each divisional member is 45 degrees. The opening/closing cap portion 20 constituted by the collection of the thus finely divided members can be smoothly opened/closed without requiring any circumferential elasticity.

It is possible to increase the number of the divisional members, for example, to divide the cap portion 20 into 9 to 20 members. In this case, sharp divisional members stand outwardly side by side in the opened state of the cap portion, so that there is a danger that the divisional members may injure circumferential portions when they touch the latter. For example, if the outer layer 2 is extended to cover the respective forward ends of the divisional members of the cover portion in the opened state of the cap portion as shown in Figure 6, the divisional members can be prevented from injuring the circumferential portions.

The opened state of the cap portion is maintained as long as a laser beam is emitted, because the laser beam continues to heat the cover. If the cover has been opened, the cover is little irradiated with the light so that the cover begins to cool. If the temperature of the cover is lowered to a value equal to or lower than the transformation temperature, the cover is closed.

When the light hits directly again on the thus closed cover, the cover is reopened. This oscillating phenomenon is undesirable.

Accordingly, it is desirable to arrange that a part of the light impinges on a part of the divisional members of the cover even in the opened state of the cap portion. The heat generated in the part of the divisional members of the cover is immediately transmitted all over the cover to keep the temperature at a value equal to or higher than the transformation temperature.

Although it is desirable to use Ar or N_2 gas as the gas to be fed from the blower into the inside of the optical fiber, air may be used according to circumstances. The humidity of the blow gas must be sufficiently low. The relative humidity must be equal to or lower than 40% and most preferably 0%. If a gas having high humidity is fed, water is condensed in the vicinity of the light-emitting end of the optical fiber. In the case of an optical fiber for transmitting a laser beam of a large power, a part of the laser beam is absorbed into the water drops to raise the temperature thereat. Therefore, damage may result at the output terminal of the optical fiber. Accordingly, low humidity is desired to prevent such accidents.

The pressure of the gas to be fed by the blower is sufficient if it can remove a liquid or the like at the light-emitting end. High pressure is undesirable because the quantity of the gas coming out of the light-emitting end to the outside increases. Accordingly, it is preferable to select as the pressure a value as low as possible within a range where the liquid or the like can be removed. Depending on the pressure loss in the ventilation path of the optical fiber, the pressure is preferably selected to a value equal to or less than 2 Kg/cm^2 when it is monitored by a gas pressure sensor 7 at the light source end. The pressure is preferably selected to be 1.01-1.2 Kg/cm^2.

When the laser source 5 is turned off, no laser beam is generated. The protecting cover 3 at the forward end of the optical fiber closes. The blower 6 is driven. Although the pressure in the ventilation path 8 inside the protecting outer layer 4 rises, the protecting cover 3 is in the closed state so that the gas does not come out from the light-emitting end to the outside. This state is shown in Figs. 2 and 3.

Assume now that the laser source 5 is driven. The laser beam enters the optical conductor 1 through the light source end T thereof and passes therethrough. The light coming out of the light-emitting end impinges on the back surface of the opening/closing cap portion 15 of the forward end protecting cover 3.

The opening/closing cap portion 15 is heated. Storing a shape so as to open at a high temperature, the cap portion 15 soon opens. After that, the laser beam goes straight ahead to impinge onto an object to be irradiated located in front of the fiber light-emitting end. At the same time, the gas fed from the air flow hole is pumped forward. In the case where the fiber light-emitting end is surround-

ed by a liquid or fluid body of high viscosity, the gas prevents the liquid or a solid body from approaching the fiber light-emitting end.

Figure 8 illustrates a further embodiment in which the forward end of the optical fiber is inserted into a thin pipe filled with a liquid 24 or the like and a laser beam is irradiated onto workpiece 12 from the light-emitting end.

Although the boundary surface 25 between fed gas 10 and the liquid 24 is illustrated to be spherical, it may take any of various shapes in practical cases and the shape per se is unstable. If the viscosity of the liquid 20 is made higher, the boundary surface 25 becomes more stable.

The fact that the forward end protecting cover 3 is opened can be detected by a gas pressure sensor 7. A sharp reduction in the gas pressure P indicates that the forward end protecting cover 3 has been opened.

Upon completion of working, the laser source 5 is turned off. The generation of the laser beam is stopped. The forward end protecting cover is reduced in temperature to thereby return to the original closed state. During this operation, the gas is fed continuously from the gas feeder/suction means 6. The circumferential liquid or the like is prevented by pumping of the gas from entering the forward end of the optical conductor 1. The forward end of the optical conductor 1 is thus kept clean.

Closing of the forward end protecting cover 3 is detected by the immediate increase of the pressure at the gas pressure sensor 7. In this example, the opening/closing cap portion 15 of the forward end protecting cover 3 is divided into two members. In the case where it is difficult to open/close the shape memory alloy with two members, the cap portion 15 may be divided into 3 to 10 members.

After termination of working by the laser beam, further supply of unnecessary gas can be stopped so that the laser beam can be safely used without unnecessary gas being pumped into the body of the apparatus.

The optical fiber can be used for:

(1) Laser beam working machines in the industrial field (laser cutting, heat-treating, welding); and

(2) Laser treating medical machines (laser surgical knife, laser coagulator). Particularly, the optical fiber can be suitably used where a miniaturized thin optical fiber is required.

Example I

A quartz glass fiber provided with a core as an optical conductor having a diameter of 500 µm was used.

A YAG laser having a wave length of 1.06 µm and an Ar laser having wave length of 0.56 µm can be used as a laser source for a quartz glass fiber. Here, a YAG laser having an output of 100 W was used as a light source.

The forward end protecting cover was made of a shape memory alloy consisting of Ni of 50-60% by weight and Ti of 40-50% by weight. The cover was to store a closed state at a low temperature and an opened state at a high temperature.

It is preferable not to make the back surface of the cover a mirror surface. In the case of the mirror surface, the fiber end was injured by the reflected light even in the case in which the output of the laser beam was 10 W (the output of the light source.)

Next, the back surface of the cover was made rough. The roughness was selected to be R_{max} = 10 µ. R_{max} is the maximum value of the convex-concave of the surface. Then, the output end of the optical fiber was not injured by the light reflected by the cover even when a laser beam having an output of 100 W was used.

When the laser beam was emitted, the cover was opened by heat, and when the laser beam was stopped, the cover returned again to the closed state.

As shown in Fig. 10, the forward end of the optical fiber was inserted into a thin pipe filled with a sticky liquid. As the gas to be fed, air having relative humidity not higher than 40% was used.

In the thus arranged apparatus, the YAG laser was driven. The forward end protecting cover made of the shape memory alloy was opened by the laser beam.

The pressure of the fed gas was 1.01-1.2 kg/cm^2.

A gaseous space in which the laser beam was little absorbed was formed in front of the light-emitting end of the optical fiber by the fed gas. The workpiece was worked by the laser beam. The optical fiber then drawn out. When the light-emitting end of the optical fiber was investigated, there was no marks to which a liquid was adhered.

Example II

A silver halide fiber provided with a core as an optical conductor having a diameter of 1000 µm was used.

A carbon dioxide laser having an output of 50 W and a wave length of 10.6 µm was used as the laser beam source.

As the optical fiber, it is possible to use any other infrared optical fibers, optical fibers of thallium halide such as KRS-5, and optical fibers of alkali metal halide such as cesium bromide.

As shown in Figs. 2 and 4, the forward end protecting cover was made of a shape memory alloy and arranged to have an opening/closing cap portion constituted by two divisional members.

As the shape memory alloy, a Ni-Ti alloy was used.

Also in this case, the inner surface of the cover was made rough. In the case where the inner surface was a mirror surface, the forward end of the optical fiber was injured even if the laser power was 10 W.

Dry air having humidity not higher than 40% came from the blower.

There was a plug made of plastic and the forward end of the optical fiber was inserted into a thin pipe filled with water, as shown in Fig. 8.

The opening/closing cap portion of the protecting cover could be opened owing to the irradiation by the laser beam. A space in which a liquid had been removed could be maintained in the thin pipe by air. A work could be worked by irradiating with the laser beam. At that time, the pressure of the gas was 1.01-1.2 kg/cm^2.

Claims

1. A light transmission apparatus comprising:

   an optical fibre (1) having a light receiving end and a light emitting end; and including a forward end protecting cover (3) openably/closably provided at said light emitting end, **characterised in that** said cover is formed of a shape memory alloy storing a shape so as to open at a high temperature and close at a low temperature produced respectively in response to incidence of light and stopping of incidence light.

2. An apparatus as claimed in claim 1 further comprising means (6) for supplying gas to said fibre so that gas is fed to said light emitting end to remove matter from the vicinity thereof.

3. An apparatus as in claim 1 wherein the back surface of said cover is made rough.

4. An apparatus as in claim 1 wherein the back surface of said cover is painted black.

5. An apparatus as in claim 1 wherein said cover is formed in at least two portions.

6. An apparatus as in claim 1 wherein said cover is formed in a plurality of portions.

7. An apparatus as in claim 5 or 6 wherein said portions do not extend beyond said light emitting end of said fibre when said cover is open.

8. An apparatus as in claim 1 further including a laser (5) for supplying said light to said fibre.

9. An apparatus as in claim 1 wherein said fibre includes a quartz fibre.

10. An apparatus as in claim 1 wherein said fibre includes a crystalline fibre selected from the group consisting of silver halide, thallium halide and alkali halide.

11. An apparatus as in claim 2 wherein said optical fibre includes an optical light conductor, an inner layer (2) surrounding said conductor and an outer layer (4) surrounding said inner layer to form a ventilation path (8) with said inner layer, said outer layer having a hole (9) therethrough;

    said gas supply means comprises a gas feeder/suction means (6) for feeding dry gas to said path (8) via said hole; and further comprises a gas pressure sensor (7) for monitoring the pressure of said gas in said path.

12. An apparatus as in claim 11 wherein said cover includes a cylindrical attaching portion (14) at said light emitting end for fixing said cover between said inner and outer layer and having a central opening through which said light conductor extends and a cap portion (15) covering the front end of said optical fibre.

13. A method of transmitting light comprising the steps of:

    transmitting light through an optical fibre to a light emitting end; providing a forward end openable/closable protecting cover at said light emitting end, **characterised by** forming said cover of a shape memory alloy which stores a shape so as to open at a high temperature and close at a low temperature respectively in response to incidence of light and stopping of incidence light.

14. A method as in claim 13 further comprising the step of feeding a gas along said fibre to said end to remove any matter from the vicinity of said light emitting end.

15. A method as in claim 13 wherein said gas is chosen from the group consisting of dry air, Ar and N_2, and has a relative humidity equal to or less than 40%.

16. A method as in claim 13 wherein said gas is fed at a pressure between 1.01 and 1.2 kg/cm^2.

17. A method as in claim 13 wherein said step of transmitting includes transmitting laser light.

Patentansprüche

1. Eine Lichtübertragungsvorrichtung, welche umfaßt:

   eine optische Faser (1), welche ein Lichtempfangsende und ein Lichtemissionsende aufweist; und welche eine vordere Endschutzabdeckung (3), die zum Öffnen/Verschließen an dem lichtemittierenden Ende vorgesehen ist, enthält, **dadurch gekennzeichnet,** daß die Abdeckung aus einer Formspeicherlegierung hergestellt ist, welche eine Form speichert, um so bei einer hohen Temperatur zu öffnen und bei einer niedrigen Temperatur zu schließen, wobei die Temperaturen in Reaktion auf den Einfall von Licht bzw. die Sperrung von einfallendem Licht erzeugt werden.

2. Eine Vorrichtung nach Anspruch 1, welche ferner eine Einrichtung (6) zum Zuführen von Gas zu der Faser, so daß das Gas zu dem lichtemittierenden Ende geführt wird, um Material aus seiner Umgebung zu entfernen, umfaßt.

3. Eine Vorrichtung nach Anspruch 1, wobei die hintere Oberfläche der Abdeckung rauh gemacht ist.

4. Eine Vorrichtung nach Anspruch 1, wobei die hintere Oberfläche der Abdeckung schwarz gefärbt ist.

5. Eine Vorrichtung nach Anspruch 1, wobei die Abdeckung aus wenigstens zwei Teilen gebildet ist.

6. Eine Vorrichtung nach Anspruch 1, wobei die Abdeckung aus einer Vielzahl von Teilen gebildet ist.

7. Eine Vorrichtung nach Anspruch 5 oder 6, wobei sich die Teile nicht über das lichtemittierende Ende der Faser hinaus erstrecken, wenn die Abdeckung geöffnet ist.

8. Eine Vorrichtung nach Anspruch 1, welche fern r einen Laser (5) zum Zuführen des Lichts zu der Faser enthält.

9. Eine Vorrichtung nach Anspruch 1, wobei di Faser eine Quarzfaser enthält.

10. Eine Vorrichtung nach Anspruch 1, wobei die Faser eine kristalline Faser enthält, die aus der aus Silberhalogenid, Thalliumhalogenid und Alkalihalogenid bestehenden Gruppe ausgewählt ist.

11. Eine Vorrichtung nach Anspruch 2, wobei die optische Faser einen optischen Lichtleiter, eine den Leiter umgebende innere Schicht (2) und eine die innere Schicht umgebende äußere Schicht (4) enthält, um einen Ventilationsweg (8) mit der inneren Schicht zu bilden, wobei die äußere Schicht eine durchgehende Öffnung (9) aufweist; und

    die Gaszuführungseinrichtung eine Gaszuführungs/Saugeinrichtung (6) zum Zuführen von trockenem Gas zu dem Weg (8) über die Öffnung umfaßt, und ferner einen Gasdrucksensor (7) zum Überwachen des Drucks des Gases in dem Weg umfaßt.

12. Eine Vorrichtung nach Anspruch 11, wobei die Abdeckung einen zylindrischen anhaftenden Teil (14) an dem lichtemittierenden Ende zum Befestigen der Abdeckung zwischen der inneren und äußeren Schicht, welcher eine zentrale Öffnung, durch welche sich der Lichtleiter erstreckt, aufweist und ein Kappenteil (15), das das Frontende der optischen Faser abdeckt, enthält.

13. Ein Verfahren zum Übertragen von Licht mit den Verfahrensschritten:

    Übertragen von Licht durch eine optische Faser zu einem lichtemittierenden Ende; Vorsehen einer vorderen öffnungs-/schließfähigen Endschutzabdeckung an dem lichtemittierenden Ende, **gekennzeichnet durch** Bilden der Abdeckung aus einer Formspeicherlegierung, welche eine Form speichert, um so bei einer hohen Temperatur zu öffnen und bei einer niedrigen Temperatur, in Reaktion auf den Einfall von Licht bzw. die Sperrung von Einfallslicht, zu schließen.

14. Ein Verfahren nach Anspruch 13, welches ferner den Verfahrensschritt der Zuführung von Gas entlang der Faser zu dem Ende umfaßt, um irgendwelches Material aus der Umgebung des lichtemittierenden Endes zu entfernen.

15. Ein Verfahren nach Anspruch 13, wobei das Gas aus der aus trockener Luft, Ar und N_2

bestehenden Gruppe ausgewählt ist und eine relative Feuchtigkeit gleich oder geringer als 40% aufweist.

16. Ein Verfahren nach Anspruch 13, wobei das Gas bei einem Druck zwischen 1,01 und 1,2 kg/cm² zugeführt wird.

17. Ein Verfahren nach Anspruch 13, wobei der Schritt der Übertragung die Übertragung von Laserlicht enthält.

Revendications

1. Dispositif de transmission de lumière comprenant :

   une fibre optique (1) comportant une extrémité de réception de lumière et une extrémité d'émission de lumière ; et incluant un couvercle de protection d'extrémité avant (3) pouvant s'ouvrir/se fermer qui est prévu au niveau de ladite extrémité d'émission de lumière, caractérisé en ce que ledit couvercle est réalisé en un alliage à mémoire de forme qui mémorise une forme de manière à s'ouvrir à une température élevée et à se fermer à une température faible produites respectivement en réponse à l'arrivée en incidence d'une lumière et à l'arrêt de l'arrivée en incidence d'une lumière.

2. Dispositif selon la revendication 1, comprenant en outre un moyen (6) pour appliquer du gaz sur ladite fibre de telle sorte que du gaz soit appliqué à ladite extrémité d'émission de lumière pour ôter toute matière de son voisinage.

3. Dispositif selon la revendication 1, dans lequel la surface arrière dudit couvercle est rendue rugueuse.

4. Dispositif selon la revendication 1, dans lequel la surface arrière dudit couvercle est peinte en noir.

5. Dispositif selon la revendication 1, dans lequel ledit couvercle est formé selon au moins deux parties.

6. Dispositif selon la revendication 1, dans lequel ledit couvercle est formé selon une pluralité de parties.

7. Dispositif selon la revendication 5 ou 6, dans lequel lesdites parties ne s'étendent pas au-delà de ladite extrémité d'émission de lumière de ladite fibre lorsque ledit couvercle est ouvert.

8. Dispositif selon la revendication 1, incluant en outre un laser (5) pour appliquer ladite lumière sur ladite fibre.

9. Dispositif selon la revendication 1, dans lequel ladite fibre inclut une fibre en quartz.

10. Dispositif selon la revendication 1, dans lequel ladite fibre inclut une fibre cristalline choisie dans le groupe qui comprend de l'halogénure d'argent, de l'halogénure de thallium et de l'halogénure alcalin.

11. Dispositif selon la revendication 2, dans lequel ladite fibre inclut un conducteur de lumière optique, une couche interne (2) qui entoure ledit conducteur et une couche externe (4) qui entoure ladite couche interne pour former une voie de ventilation (8) avec ladite couche interne, ladite couche externe comportant un trou (9) qui la traverse ;

    ledit moyen d'application de gaz comprend un moyen d'alimentation/aspiration de gaz (6) pour alimenter du gaz sec dans ladite voie (8) via ledit trou ; et comprend en outre un capteur de pression de gaz (7) pour surveiller la pression dudit gaz dans ladite voie.

12. Dispositif selon la revendication 11, dans lequel ledit couvercle inclut une partie de fixation cylindrique (14) au niveau de ladite extrémité d'émission de lumière pour fixer ledit couvercle entre ladite couche interne et ladite couche externe, et comporte une ouverture centrale au travers de laquelle ledit conducteur de lumière s'étend et une partie de bouchon (15) qui recouvre l'extrémité avant de ladite fibre optique.

13. Procédé de transmission de lumière comprenant les étapes de :

    transmission de la lumière au travers d'une fibre optique jusqu'à une extrémité d'émission de lumière ; fourniture d'un couvercle de protection pouvant s'ouvrir/se fermer d'extrémité avant au niveau de ladite extrémité d'émission de lumière, caractérisé par la formation dudit couvercle en un alliage à mémoire de forme qui mémorise une forme de manière à s'ouvrir à une température élevée et à se fermer à une température faible respectivement en réponse à l'arrivée en incidence d'une lumière et à l'arrêt de l'arrivée en incidence d'une lumière.

14. Procédé selon la revendication 13, comprenant en outre l'étape d'alimentation d'un gaz le long de ladite fibre jusqu'à ladite extrémité afin d'ôter toute matière du voisinage de ladite

extrémité d'émission de lumière.

15. Procédé selon la r v ndication 13, dans lequel ledit gaz est choisi parmi le groupe comprenant de l'air sec, de l'Ar et du N_2 et il présente une humidité relative égale ou inférieure à 40%.

16. Procédé selon la revendication 13, dans lequel ledit gaz est appliqué à une pression qui se situe entre 1,01 et 1,2 kg/cm^2.

17. Procédé selon la revendication 13, dans lequel ladite étape de transmission inclut la transmission d'une lumière laser.

FIG. 1

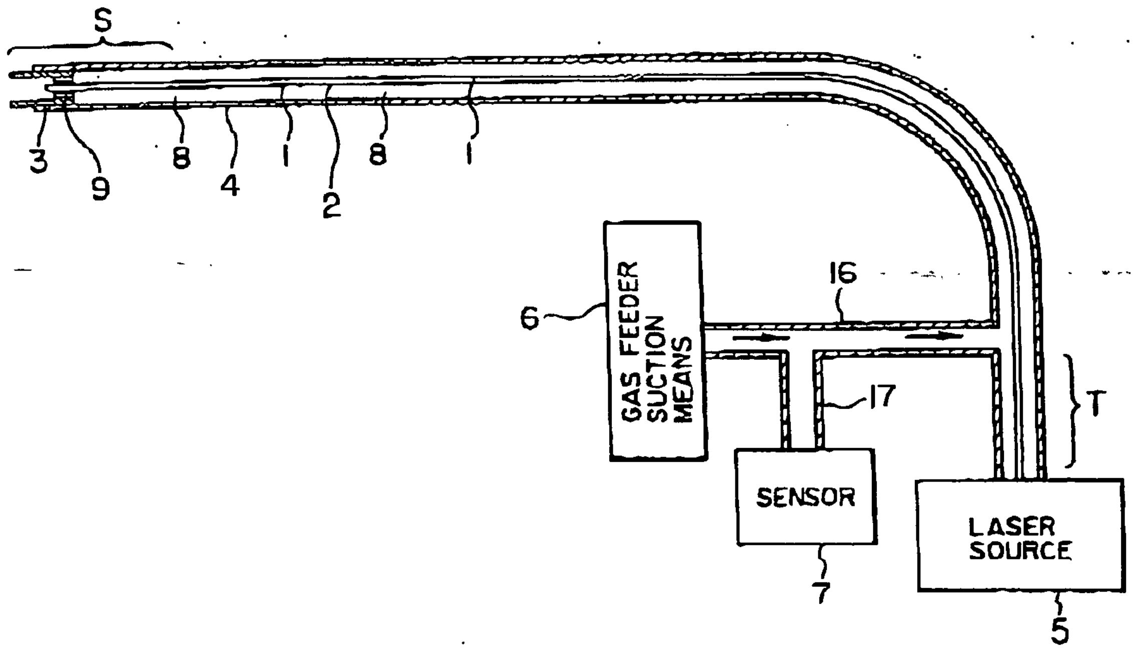
S
3
9
8
4
1
2
8
1
GAS FEEDER SUCTION MEANS
6
16
17
T
SENSOR
7
LASER SOURCE
5

FIG. 2

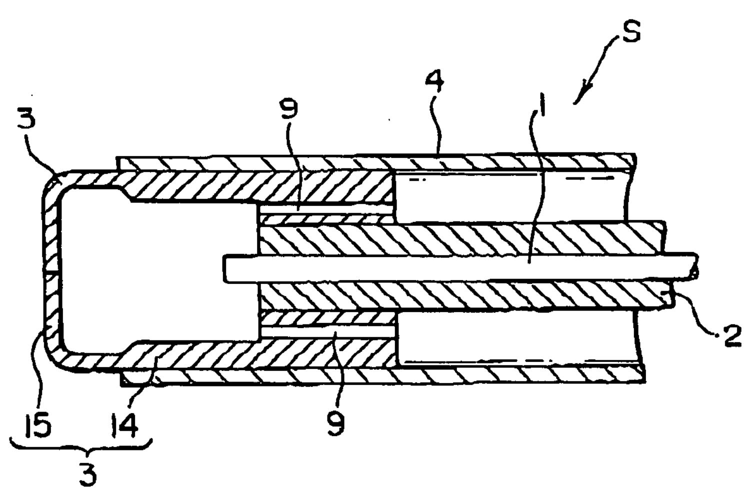
S
4
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FIG. 3

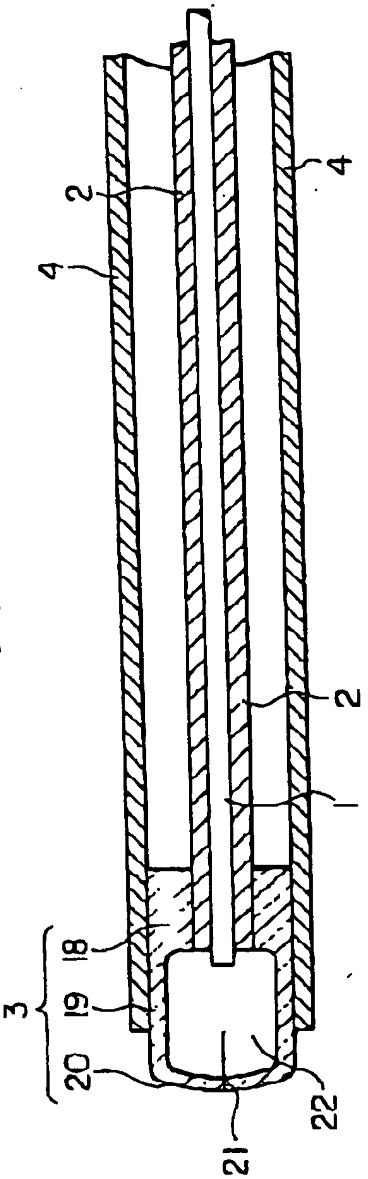

FIG. 4

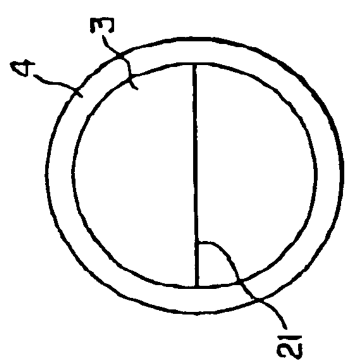

FIG. 5

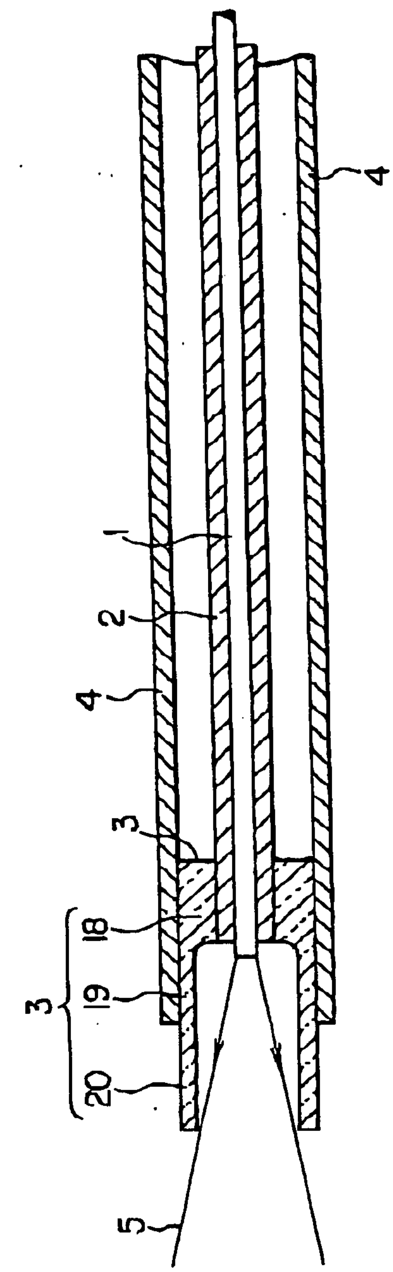

FIG. 6

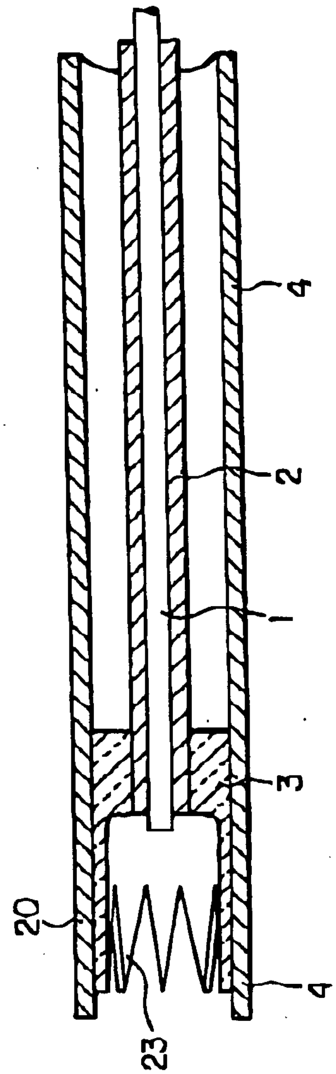

FIG. 8

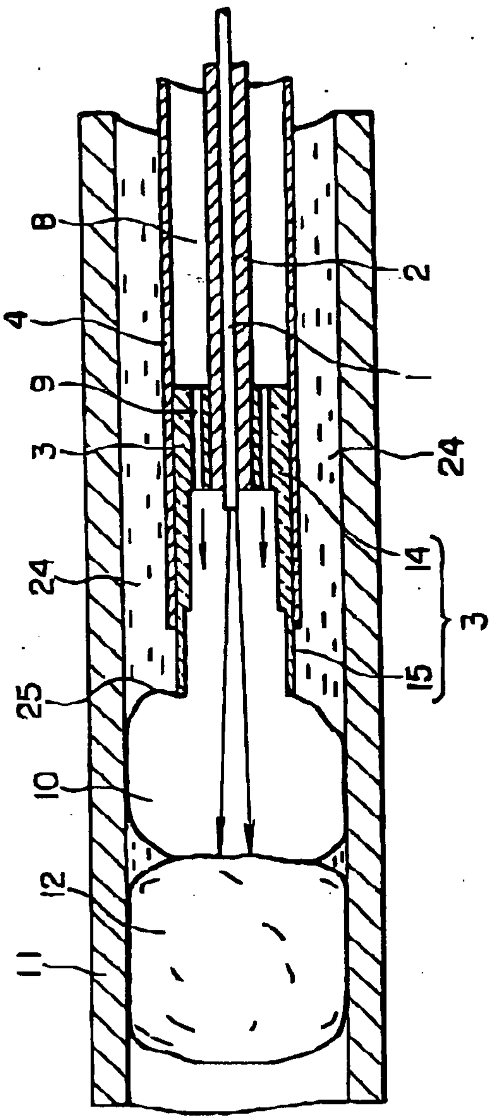

FIG. 7